FORM PTO-1390 (REV 11-2000)	U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 265-106
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U S APPLICATION NO (If known, see 37 C F R 1 5) 10/049809 unknown
INTERNATIONAL APPLICATION NO. PCT/EP00/07236	INTERNATIONAL FILING DATE 27/07/2000	PRIORITY DATE CLAIMED 17/08/1999

TITLE OF INVENTION

HIGH-FREQUENCY PHASE SHIFTER UNIT

APPLICANT(S) FOR DO/EO/US

GÖTTL, M. et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The U.S. has been elected by the expiration of 19 months from the priority date (Article 31).
5. A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☒ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has **NOT** expired.
   d. ☐ have not been made and will not be made.
8. ☒ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ A English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 To 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information. PTO Form 1449 and 6 Cited References

603462

10/049809 JC13 Rec'd PCT/PTO 19 FEB 2002

U.S. APPLICATION NO (If known, see 37 C.F.R. 1.5) 10/049809 unknown	INTERNATIONAL APPLICATION NO PCT/EP00/07236	ATTORNEY'S DOCKET NUMBER 265-106

21. ☒ The following fees are submitted:

	CALCULATIONS PTO USE ONLY		
BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):			
-- Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1040.00			
-- International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00			
-- International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO $740.00			
-- International preliminary examination fee (37 C.F.R. 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00			
-- International preliminary examination fee (37 C.F.R. 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00			
ENTER APPROPRIATE BASIC FEE AMOUNT =	$	890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).	$	0.00	

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE			
Total Claims	22	-20 =	2	X	$18.00	$	36.00
Independent Claims	2	-3 =	0	X	$84.00		0.00
MULTIPLE DEPENDENT CLAIMS(S) (if applicable)					$280.00	$	0.00
CLAIM FEES ARE NOT BEING PAID AT THIS TIME				**TOTAL OF ABOVE CALCULATIONS =**		$	**926.00**
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.							0.00
					SUBTOTAL =	$	**926.00**
Processing fee of $130.00, for furnishing the English Translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(f)).					+		0.00
					TOTAL NATIONAL FEE =	$	**926.00**
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). **$40.00** per property					+	$	40.00
Fee for Petition to Revive Unintentionally Abandoned Application ($1280.00 – Small Entity = $640.00)						$	0.00
					TOTAL FEES ENCLOSED =	$	**966.00**
					Amount to be: refunded	$	
					Charged	$	

a. ☒ A check in the amount of $966.00 to cover the above fees is enclosed.
b. ☐ Please charge my Deposit Account No. 14-1140 in the amount of $_____ to cover the above fees. A duplicate copy of this form is enclosed.
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 14-1140. A duplicate copy of this form is enclosed.
d. ☒ The entire content of the foreign application(s), referred to in this application is/are hereby incorporated by reference in this application.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

NIXON & VANDERHYE P.C.
1100 North Glebe Road, 8th Floor
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SIGNATURE

Arthur R. Crawford
NAME

25,327 REGISTRATION NUMBER

February 19, 2002 Date

603462

#4/a

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

GÖTTL, M. et al. Atty. Ref.: 265-106

Serial No. unknown Group:

Filed: February 19, 2002 Examiner:

For: HIGH-FREQUENCY PHASE SHIFTER UNIT

* * * * * * * * * * *

February 19, 2002

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

PRELIMINARY AMENDMENT

In order to place the above-identified application in better condition for examination, please amend the application as follows:

IN THE SPECIFICATION

Please substitute the following paragraphs in the specification for corresponding paragraphs previously presented. A copy of the amended specification paragraphs showing current revisions is attached.

Page 1, before the first line, please insert as a separate paragraph:

This application is the US national phase of international application PCT/EP00/07236 filed 27 July 2000, which designated the US.

IN THE CLAIMS

Please substitute the following amended claims for corresponding claims previously presented. A copy of the amended claims showing current revisions is attached.

3. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the connection lines (31a - 31d) at the same time represent transformers, via which the power is shared in a defined manner between the tapping sections (27a -27d) of the plurality of stripline sections (21a -21d).

4. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the tapping element (25) is formed like a radial point element originating from the pivoting axis (23).

5. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the share of the power which is fed in via the feed line (13) decreases from the innermost stripline section (21a) to the outermost stripline section (21d).

6. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the share of the power which is fed in via the feed line (13) increases from the innermost stripline section (21a) to the outermost stripline section (21d).

7. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that at least two of the stripline sections (21a - 21d), and preferably groups of at least two, or all, of the stripline sections (21a - 21d), are fed with the same power, or virtually the same power.

8. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the radius or diameter of the stripline sections (21a - 21d) increases by a constant factor.

9. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the distances between the stripline sections (21a - 21d) are 0.1 to 1.0 times the transmitted RF wavelength.

10. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the tapping sections (27a - 27d) are in the form of capacitively coupled tapping sections (27), which are each composed of flat strip conductors, between which a dielectric (37) is arranged.

11. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that a capacitive coupling is provided between the center tap (29), which is electrically connected to the feed line (13), and the coupling section (33), which is electrically

connected to the tapping element (25), and this capacitive coupling comprises a dielectric (37b) which is provided between two stripline sections.

12. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that this phase shift assembly is formed on a conductive, in particular metallic, base plate (25), which is preferably formed by the reflector of the antenna (1).

13. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that this phase shift assembly is shielded by a metallic cover.

14. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the connection line (31a - 31d) and the stripline sections (21a - 21d), together with the cover for the phase shift assembly, are in the form of a triplate line.

15. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the stripline sections (21a - 21d) each have a defined characteristic impedance.

16. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that a center tap (29) for the tapping element (25) is separated from, and is held above, the reflector (35) by means of a dielectric (37a).

17. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the at least two stripline sections (21a, 21b) are curved, and in particular are in the form of circle segments.

19. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the center points of the stripline sections (21a to 21c) lie on the pivoting axis (23) of the tapping element (25).

20. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the center points of the stripline sections (21a to 21c) and the center point of the pivoting axis (23) are offset with respect to one another.

21. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the stripline sections (21a to 21c) have different thicknesses.

22. (Amended) The phase shift assembly as claimed in claim 1, **characterized** in that the stripline sections (21a to 21c) have different impedance values or identical impedance values, in particular around 50 Ohms.

24. (New) A radio-frequency phase shift assembly having the following features:

- having at least two stripline sections (21a, 21b, 21c, 21d) which are arranged offset with respect to one another,

- on the at least two stripline sections (21a, 21b, 21c, 21d), at least two different pairs of antenna radiating elements (1a, 1b, 1c, 1d, 1e, 1f) can be driven with different phase angles (□) at mutually offset tapping points (39a, 39b),

- having a tapping element (25) which can be pivoted about a pivoting axis (23)

- the tapping element (25) has a tapping section (27) for each stripline section (21a, 21b, 21c, 21d), which tapping section (27) can be pivoted over the associated stripline section (21a, 21b, 21c, 21d) and is connected thereto,

- the tapping element (25) is in this case furthermore connected at least indirectly to a feed line (13) such that the feed line (13) is electrically connected via a number of connection lines (31a, 31b, 31c, 31d) to the tapping sections (27) which are associated with the individual stripline sections (21a, 21b, 21c, 21d),

characterized by the following further features:

- the stripline sections (21a - 21c) run in straight lines, and are preferably formed parallel to one another

- the tapping element (25) is formed like a pointer element which rotates about the pivoting axis (23),

- for this purpose, the respective connection line (31a – 31d) is formed with respect to a next, further outward stripline section (21b –21d) by extending the

respective preceding further inward connection line (31a – 31c) which leads to the respective further inward tapping section (27a – 27c).

REMARKS

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page(s) is captioned "**Version With Markings To Show Changes Made**."

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: _____

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GÖTTL, M. et al.
Serial No. **unknown**

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Page 1, before the first line, please insert as a separate paragraph:

This application is the US national phase of international application PCT/EP00/07236 filed 27 July 2000, which designated the US.

IN THE CLAIMS

2. (Cancel) ~~The phase shift assembly as claimed in claim 1, **characterized** in that the connection lines (31a - 31d) at the same time represent transformers, via which the power is shared in a defined manner between the tapping sections (27a - 27d) of the plurality of stripline sections (21a - 21d).~~

3. (Amended) The phase shift assembly as claimed in claim 1, ~~2 or 3,~~ **characterized** in that the ~~tapping element (25) is formed like a radial point element originating from the pivoting axis (23)~~ connection lines (31a - 31d) at the same time represent transformers, via which the power is shared in a defined manner between the tapping sections (27a -27d) of the plurality of stripline sections (21a -21d).

4. (Amended) The phase shift assembly as claimed in claim 1, ~~2 or 3,~~ **characterized** in that the ~~plurality of connections (31a - 31d) are arranged in an overlapping but isolated arrangement with respect to one another parallel to~~tapping element (25) is formed like a radial point element originating from the pivoting axis (23)

~~such that the individual connection lines (31 – 31d) each start at the center tap (29) or at the central coupling section (33), and run to the respective tapping section (27a – 27d) associated with a specific stripline section (21a – 21d).~~

5. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 4~~, **characterized** in that the share of the power which is fed in via the feed line (13) decreases from the innermost stripline section (21a) to the outermost stripline section (21d).

6. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 4~~, **characterized** in that the share of the power which is fed in via the feed line (13) increases from the innermost stripline section (21a) to the outermost stripline section (21d).

7. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 6~~, **characterized** in that at least two of the stripline sections (21a - 21d), and preferably groups of at least two, or all, of the stripline sections (21a - 21d), are fed with the same power, or virtually the same power.

8. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 7~~, **characterized** in that the radius or diameter of the stripline sections (21a - 21d) increases by a constant factor.

9. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 8~~, **characterized** in that the distances between the stripline sections (21a - 21d) are 0.1 to 1.0 times the transmitted RF wavelength.

10. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 9~~, **characterized** in that the tapping sections (27a - 27d) are in the form of capacitively coupled tapping sections (27), which are each composed of flat strip conductors, between which a dielectric (37) is arranged.

11. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 10~~, **characterized** in that a capacitive coupling is provided between the center tap (29), which is electrically connected to the feed line (13), and the coupling section (33), which is electrically connected to the tapping element (25), and this capacitive coupling comprises a dielectric (37b) which is provided between two stripline sections.

12. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 11~~, **characterized** in that this phase shift assembly is formed on a conductive, in particular metallic, base plate (25), which is preferably formed by the reflector of the antenna (1).

13. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 12~~, **characterized** in that this phase shift assembly is shielded by a metallic cover.

14. (Amended) The phase shift assembly as claimed in ~~one of~~ claims 1 ~~to 13~~, **characterized** in that the connection line (31a - 31d) and the stripline sections (21a - 21d), together with the cover for the phase shift assembly, are in the form of a triplate line.

15. (Amended) The phase shift assembly as claimed in ~~one of~~ claims 1 ~~to 14~~, **characterized** in that the stripline sections (21a - 21d) each have a defined characteristic impedance.

16. (Amended) The phase shift assembly as claimed in ~~one of~~ claims 1 ~~to 15~~, **characterized** in that a center tap (29) for the tapping element (25) is separated from, and is held above, the reflector (35) by means of a dielectric (37a).

17. (Amended) The phase shift assembly as claimed in ~~one of~~ claims 1 ~~to 16~~, **characterized** in that the at least two stripline sections (21a, 21b) are curved, and in particular are in the form of circle segments.

19. (Amended) The phase shift assembly as claimed in ~~one of~~ claims 1 ~~to 18~~, **characterized** in that the center points of the stripline sections (21a to 21c) lie on the pivoting axis (23) of the tapping element (25).

20. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 17~~, **characterized** in that the center points of the stripline sections (21a to 21c) and the center point of the pivoting axis (23) are offset with respect to one another.

21. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 16~~, **characterized** in that the stripline sections (21a to 21c) ~~run in straight lines, and are preferably formed parallel to one another~~ have different thicknesses.

22. (Amended) The phase shift assembly as claimed in ~~one of~~ claims ~~1 to 21~~, **characterized** in that the stripline sections (21a to 21c) have different ~~thicknesses~~impedance values or identical impedance values, in particular around 50 Ohms.

~~23.~~ (Cancel) ~~The phase shift assembly as claimed in one of claims 1 to 22, characterized in that the stripline sections (21a to 21c) have different impedance values or identical impedance values, in particular around 50 Ohms.~~

24. (New) 2. A radio-frequency phase shift assembly having the following features:

- having at least two stripline sections (21a, 21b, 21c, 21d) which are arranged offset with respect to one another,

- on the at least two stripline sections (21a, 21b, 21c, 21d), at least two different pairs of antenna radiating elements (1a, 1b, 1c, 1d, 1e, 1f) can be driven with different phase angles ( ) at mutually offset tapping points (39a, 39b),

- having a tapping element (25) which can be pivoted about a pivoting axis (23)

- the tapping element (25) has a tapping section (27) for each stripline section (21a, 21b, 21c, 21d), which tapping section (27) can be pivoted over the associated stripline section (21a, 21b, 21c, 21d) and is connected thereto,

- the tapping element (25) is in this case furthermore connected at least indirectly to a feed line (13) such that the feed line (13) is electrically connected via a number of connection lines (31a, 31b, 31c, 31d) to the tapping sections (27) which are associated with the individual stripline sections (21a, 21b, 21c, 21d),

characterized by the following further features:

- the stripline sections (21a - 21c) run in straight lines, and are preferably formed parallel to one another

- the tapping element (25) is formed like a pointer element which rotates about the pivoting axis (23),

- for this purpose, the respective connection line (31a – 31d) is formed with respect to a next, further outward stripline section (21b –21d) by extending the respective preceding further inward connection line (31a – 31c) which leads to the respective further inward tapping section (27a – 27c).

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345 P 247 PCT

Radio-frequency phase shift assembly

The invention relates to a radio-frequency phase shift assembly as claimed in the preamble of claim 1.

Phase shifters are used, for example, for trimming the delay time of microwave signals in passive or active networks. As a known principle, the delay time of a line is used to trim the phase angle of a signal and, in consequence, a variable phase angle means that the lines have a different electrically effective length.

For applications in antennas with an electrically adjustable notch in the polar diagram, the signals must have different delay times to the individual radiating elements, for example dipoles. The difference in the delay times between two adjacent radiating elements is approximately the same for a specific notch angle in an array of radiating elements arranged vertically one above the other. This delay time difference must now also be increased for larger notch angles. If the phase angles of the individual radiating elements are varied by means of phase shift assemblies, then this is an antenna with an adjustable electrical notch in the polar diagram.

According to WO 96/37922, a phase shift is known which has electrically moveable plates in order to produce a phase difference between different outputs, but at least between two outputs. This has the disadvantage that the movement of the dielectric plates also changes the impedance of the respectively affected lines, and

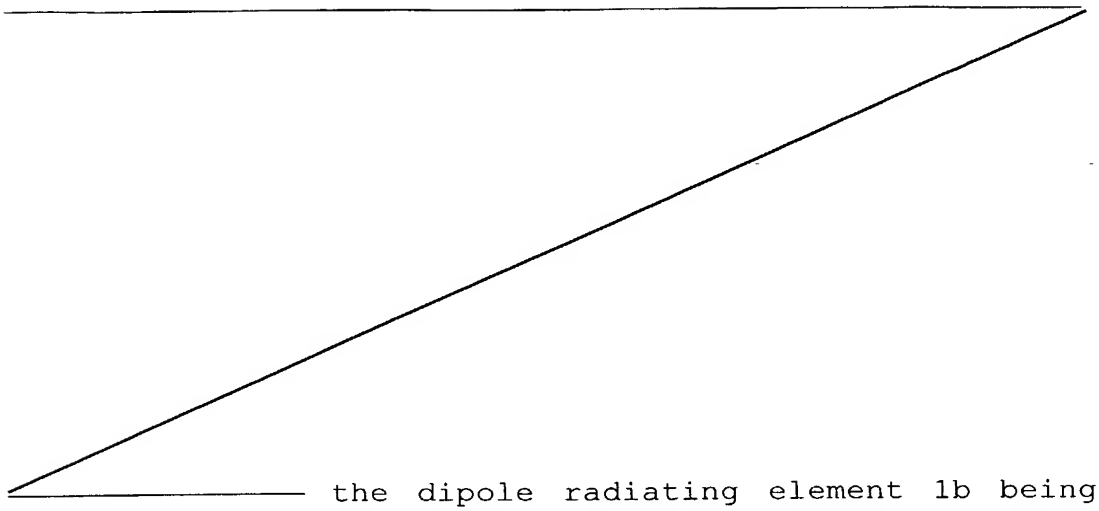
the way in which the power of the signals is shared depends on the setting of the phase shifter.

The prior publication WO 96/37009 proposes a symmetrical line branching system in order to emit the same power at both ends of this line. This can be done provided both ends are terminated by the characteristic impedance of this line. Comparable solutions of technical principles have already been used for a long time for mobile radio antennas. However, these have the disadvantage that only two radiating elements can be supplied, and they also still receive the same power. A further disadvantage is the electrically conductive connection between the input and the respective lines, which necessitates moving, but electrically high-quality contacts which may have undesirable nonlinearities, however.

Finally, in principle, it is also known for a number of phase shifters to be integrated in one antenna, via which phase shifters the individual radiating elements in the entire antenna arrangement are supplied. Since, however, individual radiating elements must have different phase differences, the phase shift assembly settings must differ for the individual radiating elements. This necessitates complex mechanical step-up transmission systems such as those shown, in principle, in Figure 1, which shows a corresponding design according to the prior art.

To this end, and in order to illustrate the prior art, Figure 1 shows, schematically, an antenna array 1 having, for example, five dipole elements 1a to 1e which, in the end, are fed via a feed input 5.

The feed input 5 is followed by a distribution network 7 which, in the illustrated exemplary embodiment, supplies two RF phase shift assemblies 9, that is to say two phase shift assemblies 9', 9'' in the

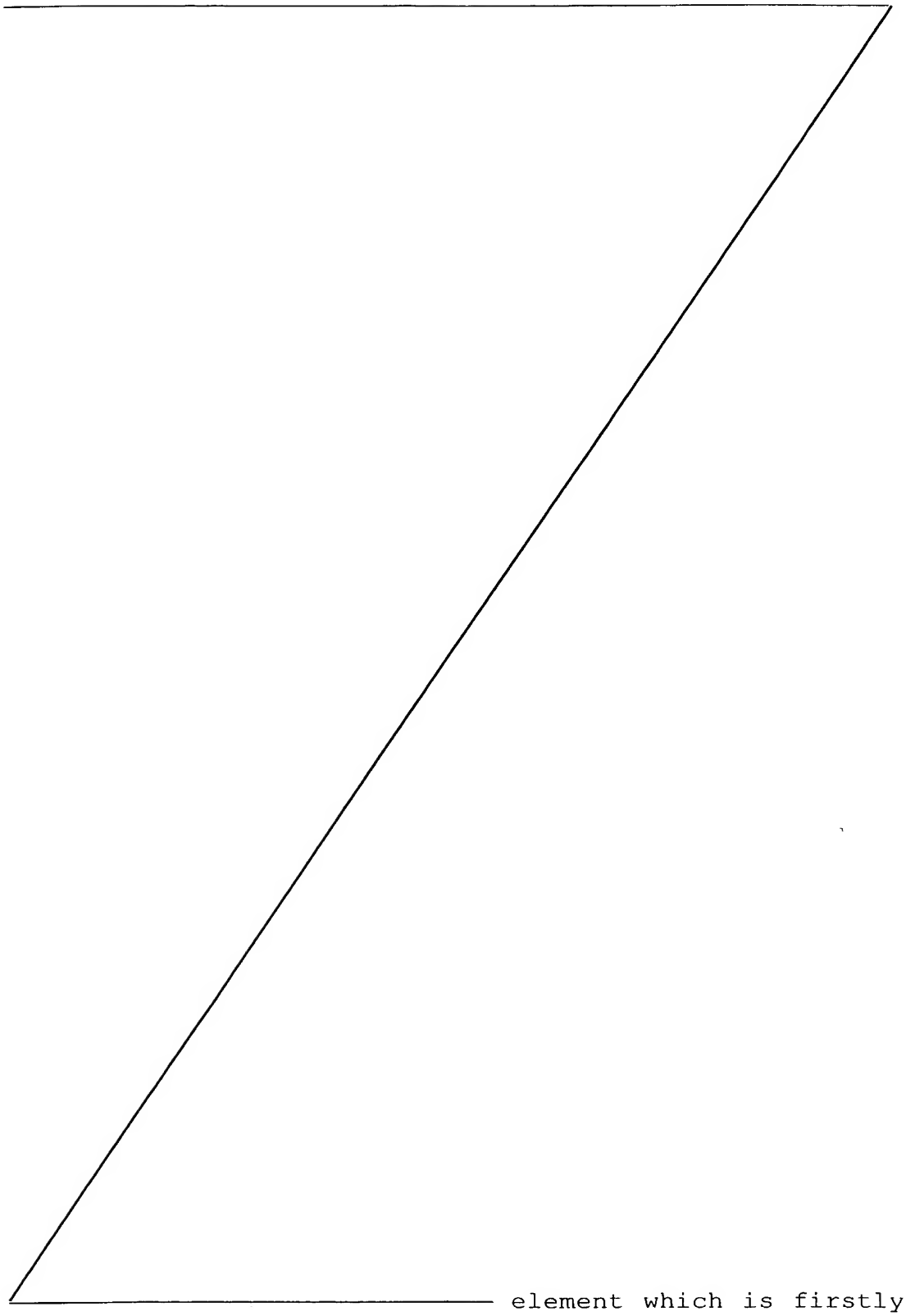


the dipole radiating element 1b being supplied with a phase $+1\phi$, the central dipole radiating element 1c being supplied with the phase $\phi = 0$, the fourth dipole radiating element 1d being supplied with the phase -1ϕ, and the last dipole radiating element 1e being supplied with the phase -2ϕ.

In consequence, the phase shift assembly 9' must therefore ensure a split of $+2\phi$ and -2ϕ, and the second phase shift assembly 9'' must ensure a phase shift of $+\phi$ and $-\phi$, for the respectively associated dipole radiating elements. A correspondingly different setting for the phase shift assemblies 9 can then be ensured by a mechanical actuating drive 17. In this case, it must be regarded as being disadvantageous that a comparatively complex mechanical step-up transmission 17 is required in order to produce the different phase differences required for the respective individual radiating elements.

A phase shift assembly of this generic type is known from PATENT ABSTRACTS OF JAPAN Vol. 1998 No. 1, January 30, 1998 (1998-01-30) -& JP 09 246846 A (NTT IDO TSUSHINMO KK), September 19, 1997 (1997-09-19). This prior publication covers two stripline segments which

are in the form of circle segments and are arranged offset with respect to one another in the circumferential direction and at a different distance from a central center point, in which case a tapping element can be moved about this center point, engaging with the respective stripline segment. The tapping element in this case comprises two radial elements, which are offset with respect to one another with an angular separation in plan view, and are connected to one another at the center point, which lies on their pivoting axis.



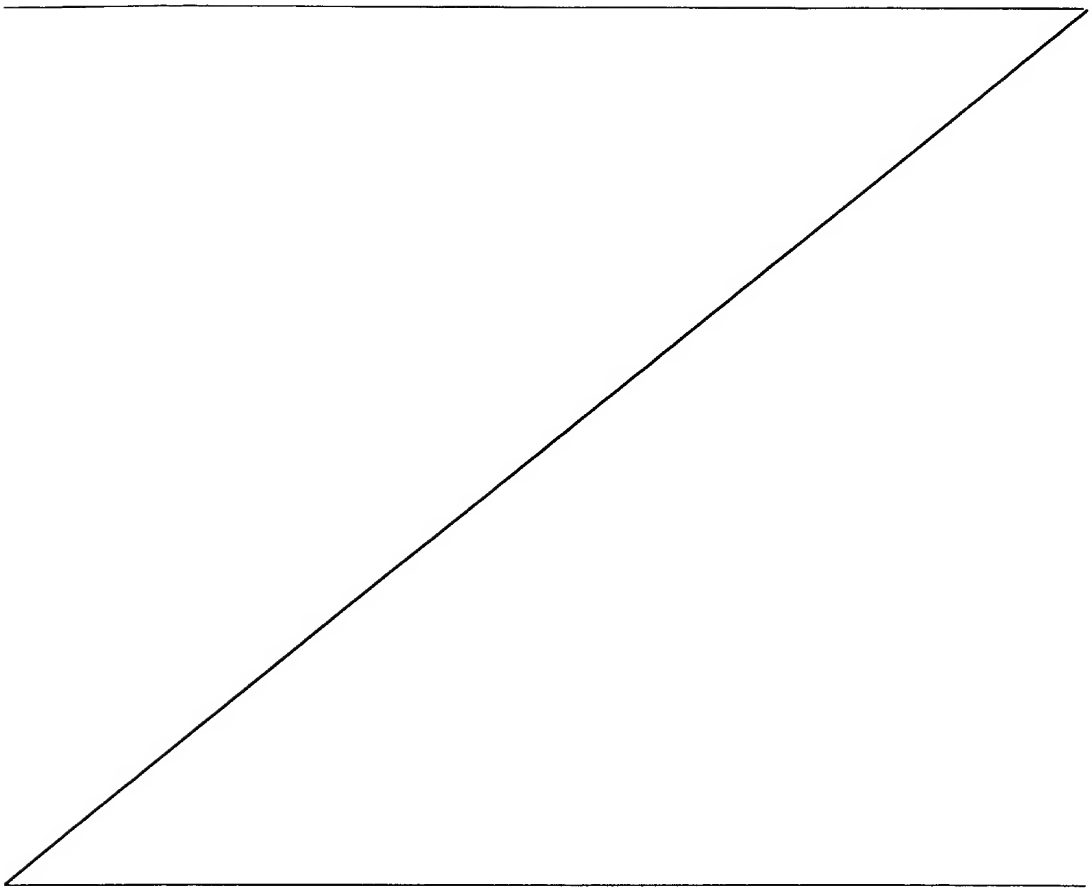
element which is firstly

connected to a feed point and secondly forms a moveable tap or coupling point in the overlapping area with the respective stripline segment, which is in the form of a circle segment. A common connection line, which extends as far as the outermost circle segment, leads from the common feed point to the individual circle segments.

As mentioned, the stripline segments may be in the form of circle segments. The stripline sections may, in general terms, also be provided arranged concentrically with respect to one another, which also includes stripline sections which run in a straight line and are arranged parallel to one another (namely for the situation where the radius of the stripline sections which are in the form of circle segments becomes infinite).

Finally, one simple refinement according to the invention comprises the provision of a tapping element which passes over a number of stripline segments in the form of circle segments, like a radially running pointer, and hence forms a number of associated tapping points which are located one behind the other in individual stripline segments.

Finally, a type of bridge structure is possible, with connection lines which run in the same direction, are arranged one above the other when seen in a horizontal side view, can be moved about a common pivoting axis, and are rigidly connected to form a common tapping element, which can be handled.



The invention will be explained in more detail in the following text with reference to drawings, in which, in detail:

Figure 1: shows a schematic illustration of a radio-frequency phase shift assembly for feeding five dipoles, according to the prior art;

Figure 2: shows a schematic plan view of a phase shift assembly according to the invention, for driving four radiating elements;

Figure 3: shows a schematic section along the tapping element in Figure 2, in order to

explain the capacitive coupling of the phase shift segment and of the center tap;

Figure 4: shows a modified exemplary embodiment of a phase shift assembly according to the invention having three circle segments;

Figure 5: shows a modified exemplary embodiment using two stripline sections which are not in the form of circle segments (which run in straight lines); and

Figures 6a and 6b show a polar diagram of an antenna array with an adjustable electrical notch, firstly for a notch at 4°, and secondly for a notch at 10°.

A first exemplary embodiment of a radio-frequency phase shift assembly according to the invention, which has stripline sections 21 offset with respect to one another, that is to say stripline segments 21 in the form of circle segments in the illustrated exemplary embodiment, namely an inner stripline segment 21a and an outer stripline segment 21b which are arranged concentrically around a common center point in a plan view and through which a vertical pivoting axis 23 runs at right angles to the plane of the drawing, will be described with reference to Figure 2.

A tapping element 25, which is designed such that it runs essentially radially in the plan view shown in

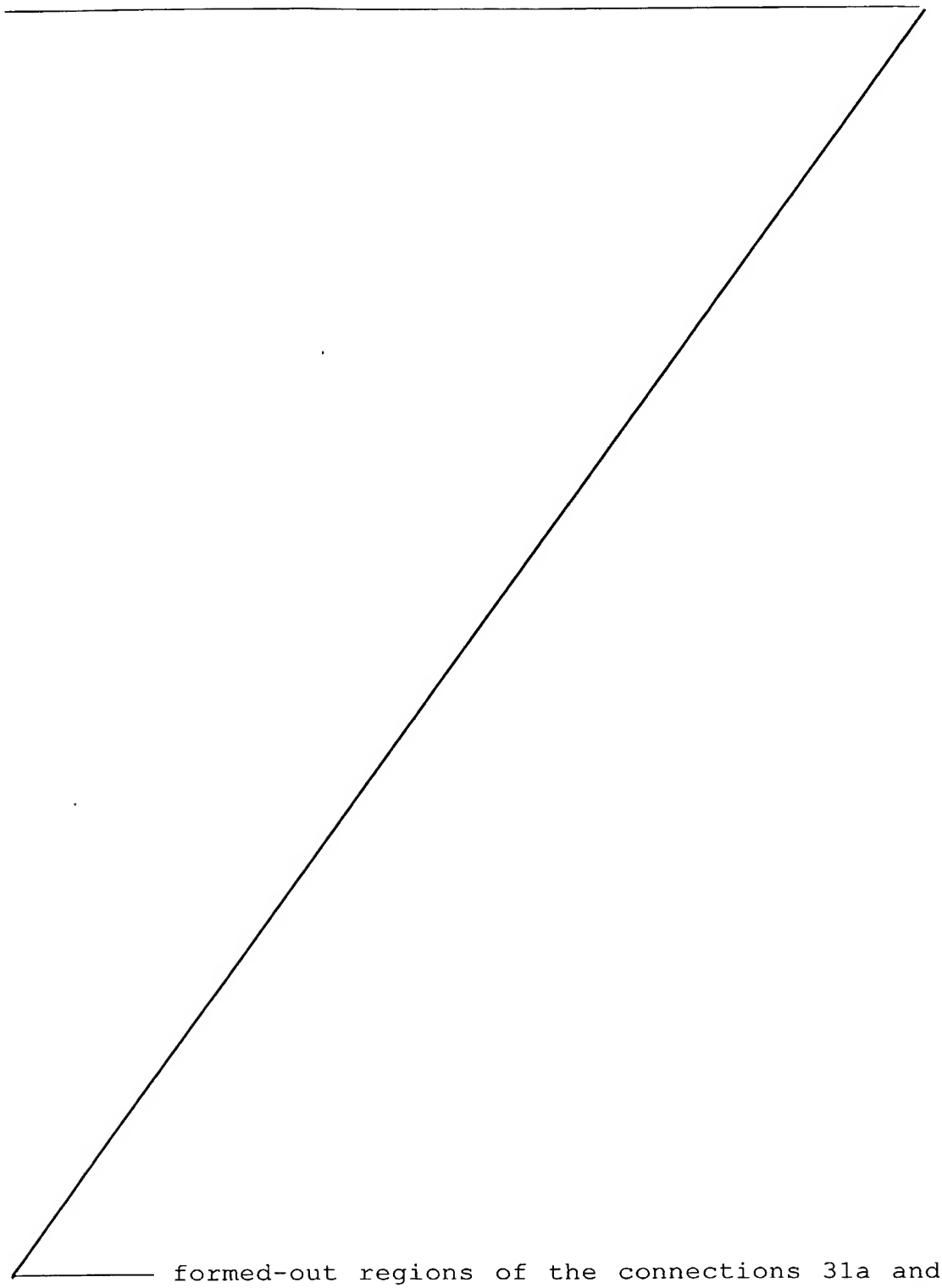
form of circle segments in the illustrated exemplary embodiment, namely an inner stripline segment 21a and an outer stripline segment 21b which are arranged concentrically around a common center point in a plan view and through which a vertical pivoting axis 23 runs at right angles to the plane of the drawing, will be described with reference to Figure 2.

A tapping element 25, which is designed such that it runs essentially radially in the plan view shown in Figure 2, runs from the pivoting axis 23 and in each case forms a coupled tapping section 27, which is also referred to as the tapping point 27 in the following text, in the respective area in which it overlaps an associated stripline segment 21, that is to say, in the illustrated exemplary embodiment, two tapping points 27a, 27b are provided, which are offset in the longitudinal direction of the tapping element 25.

The feed line 13 passes from the feed input 5 to a center tap 29, in whose region the pivoting axis 23 for the tapping element 25 is located.

The tapping element 25 is in this case broken down into a first connection line 31a, which extends from the coupling section 33 in the overlapping area of the center tap 29 to the tapping point 27a on the inner stripline segment 21a. The region which projects as an extension beyond this tapping point 27a forms the next connection section or connection line 31b, which leads to the tapping point 27b there, which is formed in the region in which it overlaps the outer stripline segment 21b.

The entire RF phase shift assembly is designed with the four dipoles 1a to 1d which are shown in the exemplary embodiment in Figure 2 jointly on a metallic base plate 35, which at the same time represents the reflector 35 for the dipoles 1a to 1d.



formed-out regions of the connections 31a and 31b between the corresponding tapping points 29 as well as 27a and 27b, respectively, now allows the power to

be shared at the same time between the dipole radiating elements 1a and 1d, on the one hand, and the further pair of dipole radiating elements 1b and 1c, since the dipole antennas 1a to 1d are connected via antenna lines 41 to each end 39a and 39b, respectively, of the stripline segments 21a, 21b, which are in the form of circle segments.

A modified exemplary embodiment with a total of six dipole radiating elements 1a to 1f is shown in Figure 4, allowing phase shifts from $+3\phi$ to -3ϕ to be achieved in this case. Furthermore, if required, it is possible to achieve power sharing, for example from outside to inside, which allows power steps of 0.5 : 0.7 : 1, as is shown in the following table.

In this exemplary embodiment, as in the previous exemplary embodiment, however, a central dipole radiating element or a central dipole radiating element group, as is shown in Figure 1, may, however, also be provided, which has a phase shift angle of 0° and is directly connected to the feed line input.

Figure 5 shows two straight stripline sections 21a and 21b, which are offset with respect to one another and, in the illustrated exemplary embodiment, are offset with respect to one another through 180° with respect to the pivoting axis 23. This refinement is admittedly not part of the invention. However, a conversion according to the invention would be feasible to the extent that the stripline sections 21a and 21b, which are shown in Figure 5, are arranged such that they run parallel to one another and run in straight lines, are arranged on the same side of the center tap 29 and, at the same time, are covered by a single tapping element 25 in the form of a pointer.

Figures 6a and 6b show the effect of a correspondingly designed antenna on the vertical polar diagram. A relatively small phase difference between the five dipoles which are shown schematically there results in a relatively small vertical depression angle, and relatively large phase difference, set via the radio-frequency phase shifter group which has been explained, results in a relatively large vertical depression angle.

Patent Claims:

1. A radio-frequency phase shift assembly having the following features:
   - having at least two stripline sections (21a, 21b, 21c, 21d) which are arranged concentrically,
   - on the at least two stripline sections (21a, 21b, 21c, 21d), at least two different pairs of antenna radiating elements (1a, 1b, 1c, 1d, 1e, 1f) can be driven with different phase angles (ϕ) at mutually offset tapping points (39a, 39b),
   - having a tapping element (25) which can be pivoted about a pivoting axis (23)
   - the tapping element (25) has a tapping section (27) for each stripline section (21a, 21b, 21c, 21d), which tapping section (27) can be pivoted over the associated stripline section (21a, 21b, 21c, 21d) and is connected thereto,
   - the tapping element (25) is in this case furthermore connected at least indirectly to a feed line (13) such that the feed line (13) is electrically connected via a number of connection lines (31a, 31b, 31c, 31d) to the tapping sections (27) which are associated with the individual stripline sections (21a, 21b, 21c, 21d),

   characterized by the following further features:
   - the tapping element (25) is formed like a pointer element which rotates about the pivoting axis (23),
   - for this purpose, the respective connection line (31a - 31d) is formed with respect to a next, further outward stripline section (21b - 21d) by extending the respective preceding

further inward connection line (31a - 31c) which leads to the respective further inward tapping section (27a - 27c).

2. The phase shift assembly as claimed in claim 1, **characterized** in that the connection lines (31a - 31d) at the same time represent transformers, via which the power is shared in a defined manner between the tapping sections (27a - 27d) of the plurality of stripline sections (21a - 21d).

3. The phase shift assembly as claimed in claim 1, 2 or 3, **characterized** in that the tapping element (25) is formed like a radial point element originating from the pivoting axis (23).

4. The phase shift assembly as claimed in claim 1, 2 or 3, **characterized** in that the plurality of connections (31a - 31d) are arranged in an overlapping but isolated arrangement with respect to one another parallel to the pivoting axis (23) such that the individual connection lines (31 - 31d) each start at the center tap (29) or at the central coupling section (33), and run to the respective tapping section (27a - 27d) associated with a specific stripline section (21a - 21d).

5. The phase shift assembly as claimed in one of claims 1 to 4, **characterized** in that the share of the power which is fed in via the feed line (13) decreases from the innermost stripline section (21a) to the outermost stripline section (21d).

6. The phase shift assembly as claimed in one of claims 1 to 4, **characterized** in that the share of the power which is fed in via the feed line (13)

increases from the innermost stripline section (21a) to the outermost stripline section (21d).

7. The phase shift assembly as claimed in one of claims 1 to 6, **characterized** in that at least two of the stripline sections (21a - 21d), and preferably groups of at least two, or all, of the stripline sections (21a - 21d), are fed with the same power, or virtually the same power.

8. The phase shift assembly as claimed in one of claims 1 to 7, **characterized** in that the radius or diameter of the stripline sections (21a - 21d) increases by a constant factor.

9. The phase shift assembly as claimed in one of claims 1 to 8, **characterized** in that the distances between the stripline sections (21a - 21d) are 0.1 to 1.0 times the transmitted RF wavelength.

10. The phase shift assembly as claimed in one of claims 1 to 9, **characterized** in that the tapping sections (27a - 27d) are in the form of capacitively coupled tapping sections (27), which are each composed of flat strip conductors, between which a dielectric (37) is arranged.

11. The phase shift assembly as claimed in one of claims 1 to 10, **characterized** in that a capacitive coupling is provided between the center tap (29), which is electrically connected to the feed line (13), and the coupling section (33), which is electrically connected to the tapping element (25), and this capacitive coupling comprises a dielectric (37b) which is provided between two stripline sections.

12. The phase shift assembly as claimed in one of claims 1 to 11, **characterized** in that this phase shift assembly is formed on a conductive, in particular metallic, base plate (25), which is preferably formed by the reflector of the antenna (1).

13. The phase shift assembly as claimed in one of claims 1 to 12, **characterized** in that this phase shift assembly is shielded by a metallic cover.

14. The phase shift assembly as claimed in one of claims 1 to 13, **characterized** in that the connection line (31a - 31d) and the stripline sections (21a - 21d), together with the cover for the phase shift assembly, are in the form of a triplate line.

15. The phase shift assembly as claimed in one of claims 1 to 14, **characterized** in that the stripline sections (21a - 21d) each have a defined characteristic impedance.

16. The phase shift assembly as claimed in one of claims 1 to 15, **characterized** in that a center tap (29) for the tapping element (25) is separated from, and is held above, the reflector (35) by means of a dielectric (37a).

17. The phase shift assembly as claimed in one of claims 1 to 16, **characterized** in that the at least two stripline sections (21a, 21b) are curved, and in particular are in the form of circle segments.

18. The phase shift assembly as claimed in 17, **characterized** in that the center points of the at least two stripline sections (21a to 21c) which

are in the form of circle segments are arranged such that they run in the form of circle segments around a common center point.

19. The phase shift assembly as claimed in one of claims 1 to 18, **characterized** in that the center points of the stripline sections (21a to 21c) lie on the pivoting axis (23) of the tapping element (25).

20. The phase shift assembly as claimed in one of claims 1 to 17, **characterized** in that the center points of the stripline sections (21a to 21c) and the center point of the pivoting axis (23) are offset with respect to one another.

21. The phase shift assembly as claimed in one of claims 1 to 16, **characterized** in that the stripline sections (21a to 21c) run in straight lines, and are preferably formed parallel to one another.

22. The phase shift assembly as claimed in one of claims 1 to 21, **characterized** in that the stripline sections (21a to 21c) have different thicknesses.

23. The phase shift assembly as claimed in one of claims 1 to 22, **characterized** in that the stripline sections (21a to 21c) have different impedance values or identical impedance values, in particular around 50 Ohms.

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Radio-frequency phase shift assembly

Abstract:

An improved radio-frequency phase shift assembly is distinguished by the following novel features:

- at least one further stripline section (21b, 21c, 21d) is provided, and is arranged concentrically with respect to the first stripline section (21a),
- further connection lines (31b, 31c, 31d) are provided, via which an electrical connection is produced at least indirectly from the feed line (13) to the respective tapping section (27a - 27d) associated with a stripline section (21a, 21b, 21c, 21d),
- two different pairs of antenna radiating elements (1a, 1b, 1c, 1d, 1e, 1f) can be driven with different phase angles (ϕ) at mutually offset tapping points (39a, 39b) on the at least two stripline sections (21a, 21b, 21c, 21d), and
- the plurality of connection lines (31a - 31d) are mechanically connected to one another.

(Figure 2)

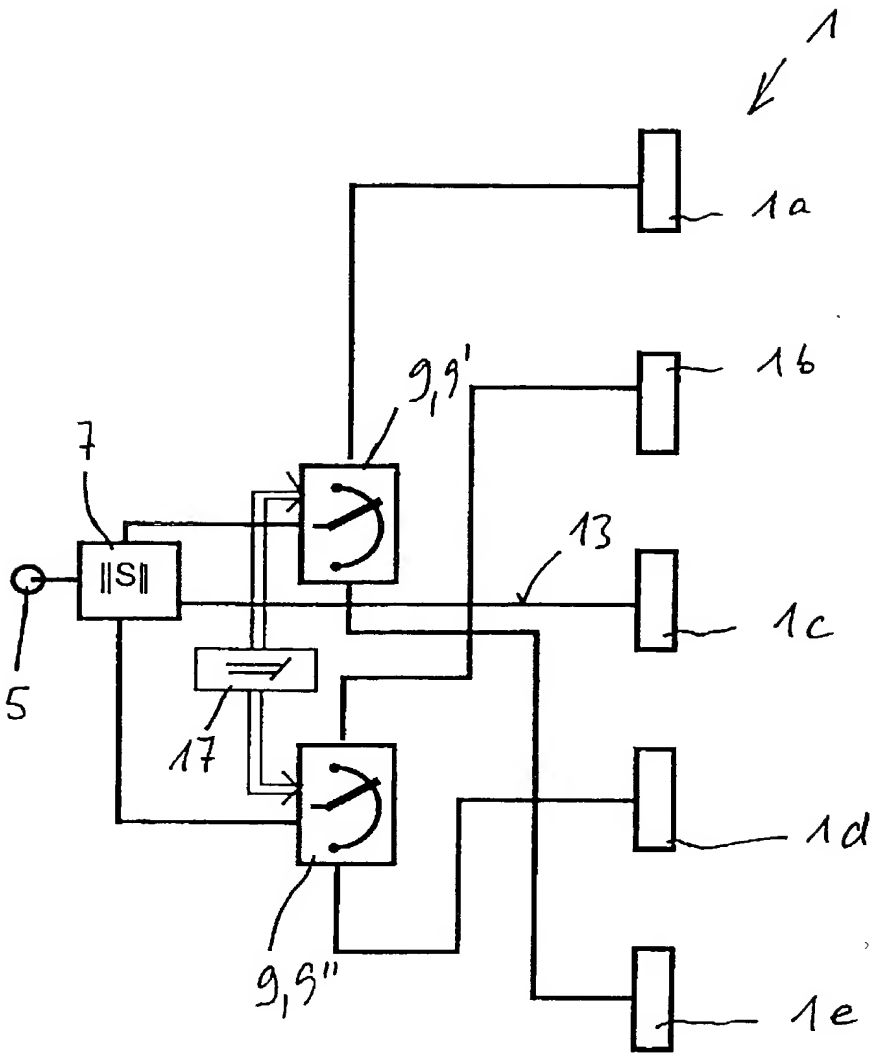
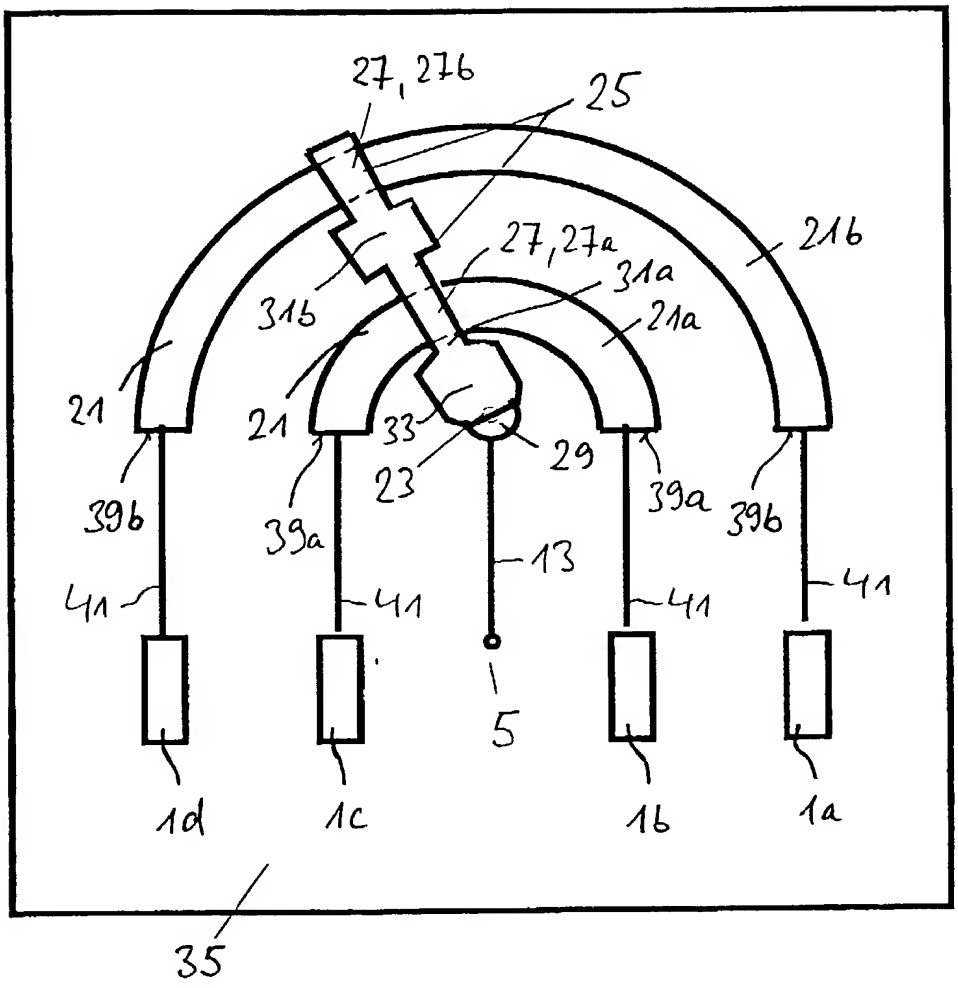


Fig. 1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25
21b
27, 27a
31a
31b
21a
21
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29
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5
1d
1c
1b
1a
35

Fig. 2

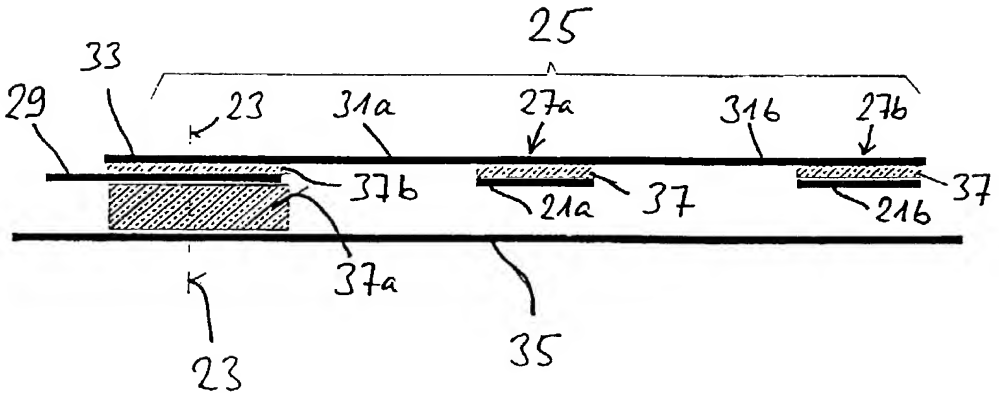

Fig. 3

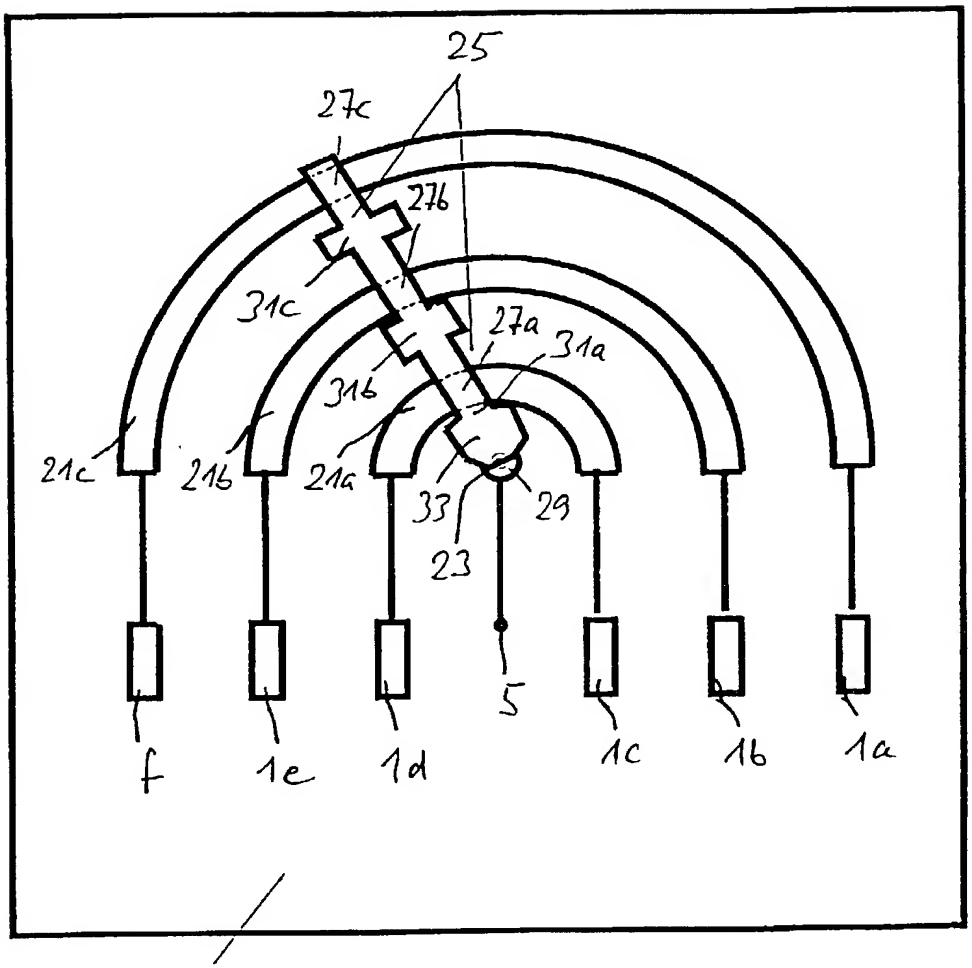

Fig. 4

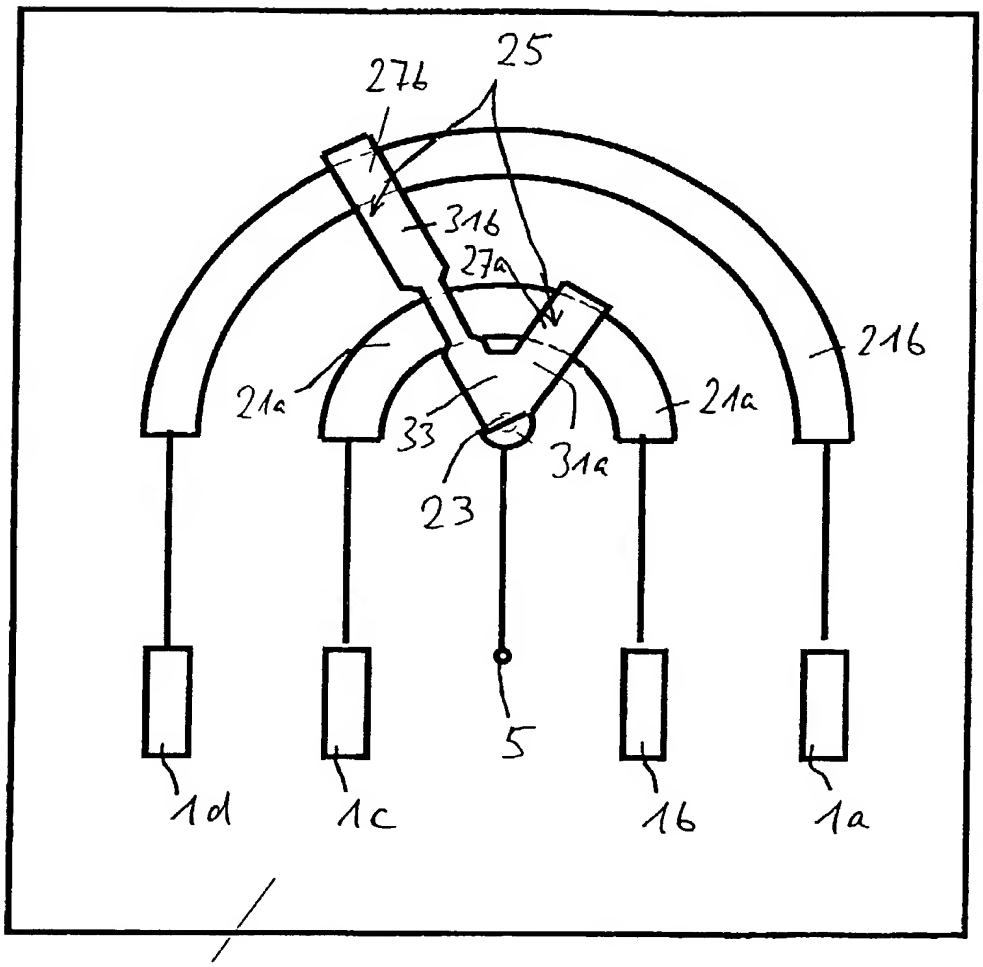

Fig. 5

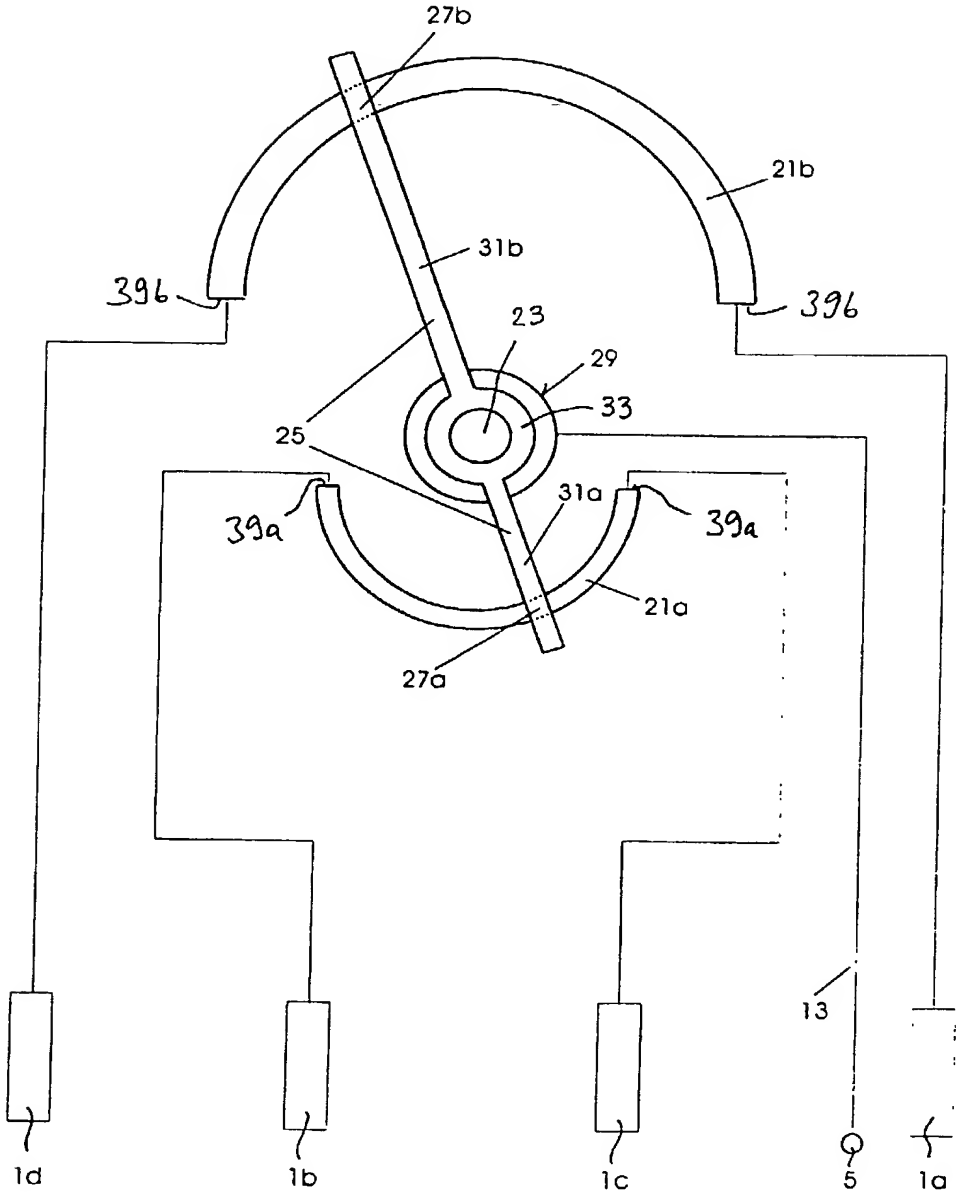

Fig. 6

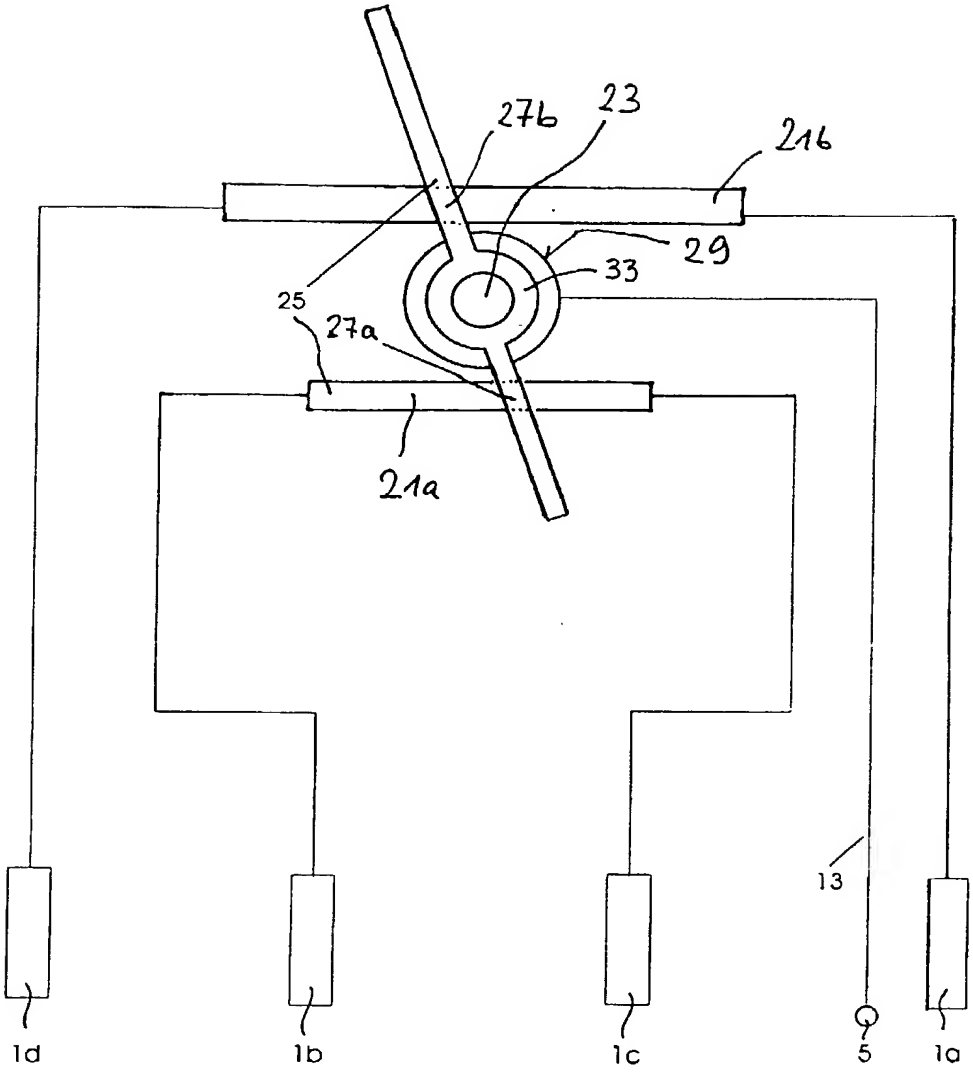

Fig. 7

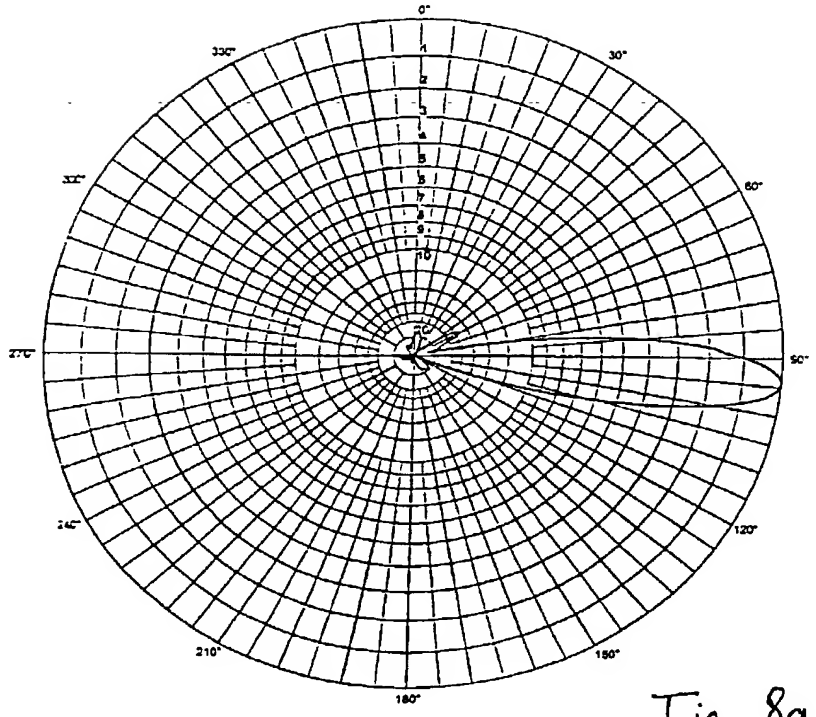
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Fig. 8a

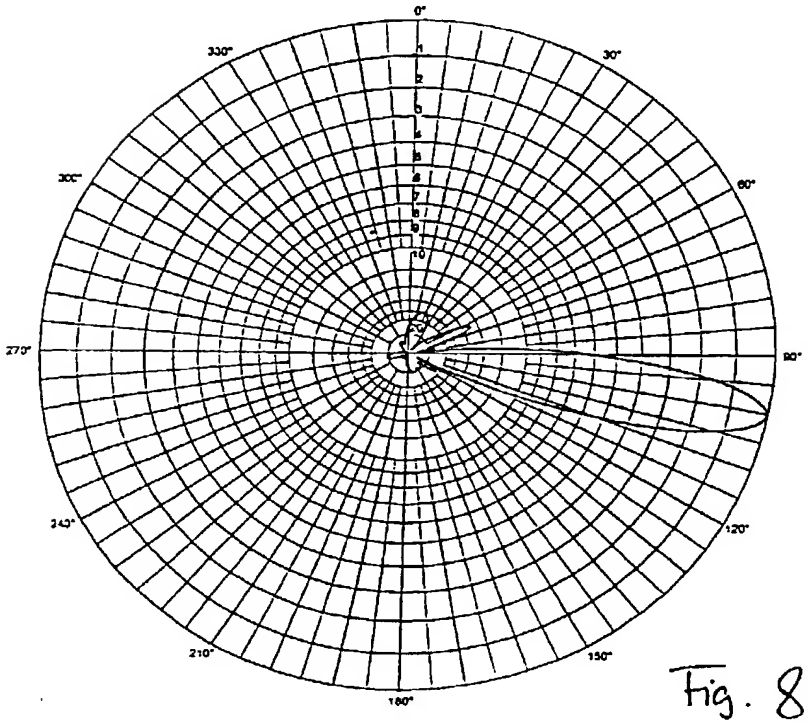
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Fig. 8b

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RULE 63 (37 C.F.R. 1.63)
INVENTORS DECLARATION FOR PATENT APPLICATION
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, mailing address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

HIGH-FREQUENCY PHASE SHIFTER UNIT

the specification of which (check applicable box(s)):

☐ is attached hereto
☐ was filed on _____ as U.S. Application Serial No. _____ (Atty Dkt. No. 265-106)
☒ was filed as PCT international application No. PCT/EP00/07236 on 27/07/2000
and (if applicable to U.S. or PCT application) was amended on 26/07/2001

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose to the Patent Office all information known to me to be material to patentability as defined in 37 C.F.R. 1.56. I hereby claim foreign priority benefits under 35 U.S.C. 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed or, if no priority is claimed, before the filing date of this application:
Priority Foreign Application(s).

Application Number	Country	Day/Month/Year Filed
199 38 862.8	DE	17/08/1999

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below.

Application Number	Date/Month/Year Filed

I hereby claim the benefit under 35 U.S.C. 120/365 of all prior United States and PCT international applications listed above or below:

Prior U.S./PCT Application(s): Application Serial No.	Day/Month/Year Filed	Status: patented pending, abandoned
PCT/EP00/07236	27/07/2000	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon. And on behalf of the owner(s) hereof, I hereby appoint **NIXON & VANDERHYE P.C., 1100 North Glebe Rd., 8th Floor, Arlington, VA 22201-4714, telephone number (703) 816-4000 (to whom all communications are to be directed)**, and the following attorneys thereof (of the same address) individually and collectively owner's/owners' attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent: Larry S. Nixon, 25640; Arthur R. Crawford, 25327; James T. Hosmer, 30184; Robert W. Faris, 31352; Richard G. Besha, 22770; Mark E. Nusbaum, 32348; Michael J. Keenan, 32106; Bryan H. Davidson, 30251; Stanley C. Spooner, 27393, Leonard C. Mitchard, 29009; Duane M. Byers, 33363; Jeffry H. Nelson, 30481; John R. Lastova, 33149; H. Warren Burnam, Jr. 29366; Mary J. Wilson, 32955; J. Scott Davidson, 33489; Alan M. Kagen, 36178; Robert A. Molan, 29834; B. J. Sadoff, 36663; James D. Berquist, 34776; Updeep S. Gill, 37334; Michael J. Shea, 34725; Donald L. Jackson, 41090; Michelle N. Lester, 32331; Frank P. Presta, 19828; Joseph S. Presta, 35329; Joseph A. Rhoa, 37515; Raymond Y. Mah, 41426; Chris Comuntzis, 31097; Gary T. Tanigawa, 43180. I also authorize Nixon & Vanderhye to delete any attorney names/numbers no longer with the firm and to act and rely solely on instructions directly communicated from the person, assignee, attorney, firm, or other organization sending instructions to Nixon & Vanderhye on behalf of the owner(s).

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2-OU

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☒ *See attached sheet(s) for additional inventor(s) information!!*

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Serial No.
3-00

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(Domestic Non-Assigned/Foreign)
Page 2

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600483

GESAMT SEITEN 05

[redacted]